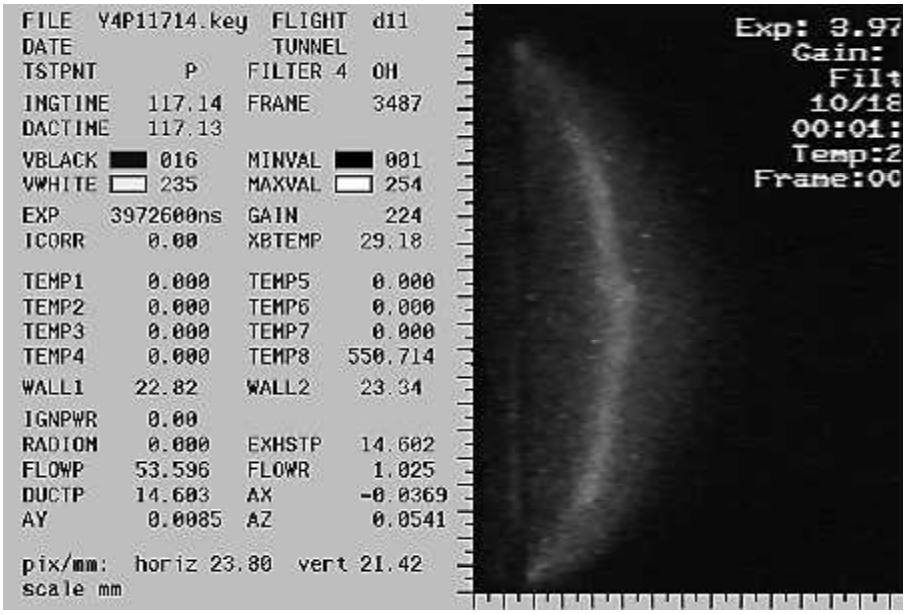
Integrated Digital Video and Experimental Data Analysis for Microgravity Combustion Experiment

The purpose of the Diffusive and Radiative Transport in Fires (DARTFire) Project is to study various mechanisms of energy transport in the ignition and growth of flames in microgravity. This sounding rocket experiment incorporates two multispectral video cameras, two 8-mm video recorders, and several temperature and pressure probes that record information on two separate flames, burning under different oxygen concentrations and flow rates. Mirrors allow each camera to view side-by-side images of both flames.

In support of this Space Experiments Division (SED) project, the Computer Services Division (CSD) at the NASA Lewis Research Center developed several programs and techniques for digitizing and analyzing video images, integrating the video with other experimental data, and providing postflight analysis of engineering mission performance.

Both onboard video cameras are black-and-white, with a rotating, six-element filter wheel that provides images of the flames for various spectral ranges. One of the cameras operates in the visible-light spectrum, and its filter wheel is synchronized with the standard video frame rate (29.97 frames/sec); exposure time is automatically varied for each frame in response to flame brightness. Filter and exposure data are encoded in barcodes superimposed on each image. The other camera operates in the infrared spectrum at a nonstandard video rate (60 half-frame images/sec); its filter wheel yields only 1 image/filter/sec; filter identity is again bar-coded on the image. The onboard data acquisition control system (DACS) sampled pressure, temperature, and status information 20 times/sec. This information was stored in 1 MB of RAM and transferred to a diskette after the flight.



Video image showing annotations for DACS data and x- and y-axis millimeter scales.

All video from the 6-min experiment was digitized to an industry-standard format that generates 8-bit 720- by 486-pixel images with a broadcast-quality digital video animation system that allows real-time sampling and storage of 50 sec of video at a time. Each experiment generates over 10 GB of data, which are made available to the researchers online.

To meet the mission's imaging requirements, programs were developed for

- Analyzing video levels and background noise, and barcoding black-and-white levels for accurate image intensity calibrations
- Tagging each image with filter and frame-accurate timing information by using bar-codes, the camera-specific frame rate, the video

  frame count, and DACS-generated synchronization marks on the video
- Annotating each image with synchronized, calibrated DACS data and x- and y-axis millimeter scales (see the figure)
- Correcting the intensity of the autoexposure images to provide consistent assessment of flame intensity and size
- Generating exposure-corrected, white-balanced full-color animation of the flames from red, green, blue images and neutral-density images filtered from the visible-light camera

Programs were also developed to graphically analyze DACS information for postflight analysis of system performance at the launch site.

The video animation system used to digitize the video was also used to animate preprocessed and postprocessed image data. Techniques are currently being developed to

use the Computer Services Division's 1935- by 1120-pixel High Definition Television (HDTV) scientific animation testbed to visualize flame shape and motion simultaneously for all filter images with no loss of resolution.

Lewis contacts: Dr. Jay G. Horowitz (CSD), (216) 433-5194, Jay.G.Horowitz@grc.nasa.gov; and Jeffrey A. Jones (SED), (216) 433-2870, Jeffrey.A.Jones@grc.nasa.gov
Author: Dr. Jay G. Horowitz
Headquarters program office: OA (HPCCO)